INTRODUCTION

This appendix replies to technical aspects of comments filed in response to AMSC's Petition seeking reallocation of additional spectrum to the Mobile-Satellite Service ("MSS"). In particular, AMSC proposed the allocation of a 10 MHz uplink (1616.5-1626.5 MHz) from the current uplink allocation for Radiodetermination-Satellite Service ("RDSS") and a matching 10 MHz downlink, preferably from the upper portion (1515-1525 MHz) of the aeronautical telemetry allocation, which is near the existing MSS downlink allocation.

Section I of this appendix responds to those that argue that the RDSS allocation should be preserved for satellite systems that provide services based on position locations derived independently of any other system. As demonstrated below, AMSC's position-location service using the U.S. government's Global Positioning System ("GPS") is superior to the proposed autonomous systems. The use of GPS in AMSC's system leads to greater accuracy, speed, reliability and spectrum efficiency than the proposed alternatives, at no added cost.

Several of the opponents of AMSC's proposed reallocation of the RDSS uplink band claim that it is important that any system operating in the band conform with the current RDSS technical requirements. Section II adds to the evidence demonstrating that none of the new proposed systems that would operate in the RDSS bands are in conformance with the current RDSS technical requirements.

Section III is a response to assertions that MSS cannot share the 1515-1525 MHz band with aeronautical telemetry users. As demonstrated therein, AMSC's initial conclusion, that sharing between MSS and aeronautical telemetry is practical and efficient, remains valid.

I. THE PERFORMANCE OF AMSC'S PROPOSED ANCILLARY RDSS IS SUPERIOR TO THAT OF ANY OF THE PROPOSED RDSS SYSTEMS

The comments of Loral, Motorola and TRW suggest that AMSC's MSS system will not provide bona fide radiodetermination-satellite service ("RDSS") and imply that AMSC's RDSS capabilities are inferior to the RDSS they propose to provide.[1/] To the contrary, AMSC proposes to provide ancillary RDSS capabilities that are generally superior to the capabilities of all of the proposed new systems. Specifically, AMSC's system will provide more accurate positions with greater speed and reliability, and these advantages are achieved with equal or greater spectrum efficiency and at no

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[1/] Comments of Motorola Satellite Communications, Inc., RM-7771, -7773, -7806, and -7805 (October 16, 1991), at 11; Comments of Loral Qualcomm Satellite Services, Inc., RM-7806, -7771, -7805, and -7773 (October 16, 1991), at 3; and Comments of TRW, Inc., RM-7806 (October 16, 1991), at 10-11. AMSC's mobile earth stations will employ the propagation properties of signals from GPS satellites in order to effect radionavigation and will convey locally-determined positions to other users in order to effect radiolocation; this is RDSS in accordance with the definition established by Radio Regulation ("RR") Nos. 39 and 10. Several satellite systems provide RDSS functions using MSS allocations, including Inmarsat-II (emergency position indicating radio beacons at 1645.5-1646.5 MHz and AMS(R)S automatic dependent surveillance at 1646.5-1660.5 MHz); COSPAS/SARSAT (emergency locator transmitters at 121.5 MHz, 243 MHz, and 406 MHz, and feeder downlinks to local user terminals at 1544-1545 MHz); Omnitracs (via domsats operating at Ku-Band); and ARGOS (tracking transmitters at 401-403 MHz).

higher cost.

By their own admissions, the systems proposed by CCI, Ellipsat, Loral, Motorola, and TRW would provide significantly less accurate location estimates than AMSC's MSS system. Table 1 presents the claimed accuracies.[2/] The accuracy of AMSC's system is the same as that of GPS, which accuracy is well-documented and substantiated in numerous references.[3/]

Table 1. Position Determination Accuracies Claimed for Proposed Systems Operating in the 1616.5-1626.5 MHz Band

APPLICANT	**CLAIMED POSITION DETERMINATION ACCURACY**
American Mobile Satellite Corp.	100 meters (0.0625 miles) C/A-code users <20 meters (<0.0125 miles) P-code users
Constellation Communications	8000 meters (5 miles)
Ellipsat	100 meters (0.0625 miles)
Loral Qualcomm Satellite Services	1600-3200 meters (1-2 miles)
Motorola Satellite Communications	1600 meters (1 mile)
TRW	400 meters (1/4 mile)

By contrast, even the generally poorer claimed accuracies for the proposed new systems are insufficiently substantiated. Table

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2/ Summary data are from "A Survey of Small Commercial Constellations," John E. Hatfield and David E. Sterling, Motorola Inc., Proceedings of the Fifth Annual AIAA Conference on Small Satellites, Utah State University, August 26-29, 1991. This paper also indicates that the position-determination accuracy of low-Earth-orbit satellite systems (OrbComm, Starsys, and Leosat) proposed for frequencies below 1 GHz surpass the accuracy of those proposing to operate above 1 GHz.

3/ The accuracy stated for AMSC's C/A code-based position location capability does not include differential-GPS enhancements. Further information on GPS is available in publications such as GPS World (News and Applications of the Global Positioning System).

2 lists a number of basic parameters necessary to determine the accuracy of RDSS systems.[4/] None of the RDSS applicants, however, provides any data as to these critical RDSS system parameters or a complete position-location error analysis that would be needed for evaluation of the merits of their proposed systems.[5/]

Table 2. Factors Delimiting the Accuracy of Doppler-Based Position-Determination Capabilities

PARAMETER	**DISCUSSION**
Oscillator Stability	The stability of all oscillators involved in the generation and processing of the signal subject to Doppler measurement, during the measurement period, is extremely critical. In order to achieve accuracy on the order of 2-5 km (1.25-3.13 miles), the on-orbit position processor of COSPAS/SARSAT requires that the mean frequency drift and short-term frequency stability of user terminal not exceed one part in 10^9 per minute and two parts in 10^9 per 100 msec, respectively. These levels of stability are not endemic to inexpensive communications terminals.

4/ See, e.g., "Error Analysis for Satellite-Aided Search and Rescue," NASA Goddard Space Flight Center Document X-932-76-86, David W. Koch, August 1976, and "Error Analysis for Relay Type Satellite-Aided Search and Rescue Systems," NASA Goddard Space Flight Center Technical Memorandum 78050, J.W. Marini, September 1976.

5/ Although RDSS is central to the proposed new systems, the applications filed by these parties provide only vague descriptions of the proposed RDSS capabilities and the underlying technologies that would enable the claimed RDSS performance levels to be achieved. Just as applications for communications satellites should present link power and noise budgets to support evaluation of communications performance, the applications for RDSS systems should provide position-location error budgets to support evaluations of position-location performance. Insofar as the proposed new systems measure Doppler shift to facilitate estimation of the location of terminals, the system parameters listed in Table 2 should be fully described and addressed as elements of a position-location error budget. Additional parameters must be considered for systems that also would utilize timing techniques based on the interrogation and response of user terminals or conveyance of a time standard.

PARAMETER	**DISCUSSION**
Satellite Position Accuracy	Errors in the accuracy with which the position of the satellite is known, both in-track and cross-track, will result in a one-to-one error component of the calculated position of a user terminal. Data supplied by Norad provides knowledge of NOAA SARSAT satellite positions with less than 1 km accuracy.
Satellite Elevation Angle	As the distance separation from the user location to the satellite ground track decreases, the potential error in the calculated terminal location increases. For the proposed low-Earth-orbit systems, this problem is complementary to the problem of poor communications quality at low elevation angles.
Time Duration of Measurement	The greater the duration of Doppler measurement, the greater the position determination accuracy. The RDSS applicants have not indicated how they will sustain a measurement as the satellites pass in and out of view.
Number of Satellites or Passes Used in Measurement	At times that only one satellite is usable because of the satellite coverage and visibility limitations of the proposed RDSS systems, position ambiguity (relative to ground track) can be resolved only through use of a supplementary interrogation-based or standard-time dissemination-based position determination or by lengthy measurement of Doppler shift before and after the satellite is at its maximum elevation angle from the user terminal.
Altitude of User Terminal	In a single-satellite solution, error in the knowledge of user terminal altitude can translate to error in position estimation. The proposed RDSS systems provide a good signal path to only one satellite (at most).
Motion of User Terminals	Substantial change in position of the user terminal during Doppler measurement can translate to substantial error in position estimation.

In addition, it is extremely doubtful that the proposed RDSS-band systems can deliver even relatively inaccurate positions as fast as AMSC's system. Speed of position determination is particularly important for applications involving navigation, especially with high speed vehicles. Again, however, the applicants have not provided sufficient data on which the speed of their RDSS services can be evaluated.

Further, as AMSC has demonstrated, the proposed new systems suffer various reliability problems that further undermine their usefulness.[6/] These endemic reliability problems are compounded by the fact that the proposed new systems are specifically denied safety status under RR No. 733A; accordingly, if an MSS allocation is adopted at the 1992 WARC, foreign MSS systems would be able to claim service status superior to that of the proposed systems in the already constraining process of international coordination of frequency assignments.[7/] In contrast, AMSC's RDSS uses the GPS system and its own MSS facilities, both of which meet the stringent reliability requirements of the aviation community.

6/ The proposed low-Earth-orbit systems suffer variously from, among other things: (1) susceptibility to disruptive interference, particularly at frequencies below 1616.5 MHz; (2) poor satellite coverage; (3) visibility at precariously low elevation angles for substantial percentages of the time; (4) spacecraft electrical power systems that may be inadequate to sustain service at high levels of usage, particularly during eclipse conditions; (5) sparse deployments of feeder link earth stations that will result in feeder link handoffs that hamper communications continuity; (6) service restoration plans that rely solely on launch of replacement satellites or repositioning of satellites and which virtually guarantee that significant outages will occur; and (7) spacecraft antenna pointing tolerances that are incapable of supporting claimed frequency reuse and capacity levels or prevention of self-interference. See Petition of AMSC, RM-7806 (June 3, 1991), Technical Appendix, and Opposition of AMSC, RM-7771, -7773, and -7805 (October 16, 1991), Technical Appendix.

7/ In light of recent events, AMSC may have understated in its Opposition, RM-7771, -7773, and -7805 (October 16, 1991), at 7-9, the coordination difficulties that may evolve in the 1616.5-1626.5 MHz band. Specifically, at the recent meeting of CCIR Working Party 7D (Geneva, 28 October - 5 November, 1991), an information paper was presented by the International Council of Scientific Unions outlining a plan for resolving harmful interference from the GLONASS radionavigation-satellite system to radio astronomy observations in the band 1610.6-1613.8 MHz (Attached as Exhibit 1). One potential solution to this problem would be for GLONASS to discontinue use of problematic frequencies in future satellites, which could necessitate GLONASS use of frequencies in the 1616.5-1626.5 MHz range. Thus, it is conceivable that MSS systems will have access to less than 10 MHz in the 1610-1626.5 MHz band.

Moreover, in utilizing signals that are generated by GPS, AMSC's RDSS is accomplished without transmission of additional position-indicating signals; thus, AMSC's RDSS is at least as spectrum efficient as the proposed RDSS systems. Further, because the GPS signals are proximate to AMSC's downlink frequencies, reception of GPS signals by AMSC's MSS user terminals can be readily and inexpensively implemented. Indeed, none of the proposed systems using LEO satellites can provide RDSS as inexpensively as AMSC.

II. THE PROPOSED LOW-EARTH-ORBIT SATELLITES WOULD BE INCOMPATIBLE WITH RDSS SYSTEMS

Despite their belief that compatibility with geostationary RDSS systems is essential, none of the applicants for the downlink band 2483.5-2500 MHz meet this compatibility test or conform with the basic technical standards that have been established for RDSS. In fact, TRW, Loral, and CCI have requested the FCC to substantially relax the power flux density ("PFD") limits on downlinks from LEO satellites in the 2483.5-2500 MHz band in order to enable voice and data services to be provided.[8/] As

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8/ See Petition of TRW, RM-7773 (June 3, 1991), at 12-13. Comments of Loral, RM-7771, -7773, -7806, and -7805 (October 16, 1991), at 8; and Comments of CCI, RM-7773 (October 16, 1991), at n. 16. AMSC already noted that the TRW application omits any analysis of sharing between its proposed system and RDSS downlinks operating at increased PFD levels in the 2483.5-2500 MHz band. AMSC Opposition, RM-7771, -7773 and -7805 (June 3, 1991), Technical Appendix, at 18. In the cited comments, Loral agrees that increased PFD levels should be considered for the proposed RDSS systems. In its comments, CCI endorses an increase in permissible PFD levels and/or an increase in the bandwidth allocated for RDSS in the 2400-2500 MHz band. The latter option is not contained in the U.S. proposals to WARC-92, nor is such an allocation likely to illustrated below, operation of LEO RDSS downlinks at elevated PFD limits would cause harmful interference to RDSS systems using geostationary satellites. Because the 2483.5-2500 MHz downlinks of all RDSS systems would have to use comparable PFD levels in order to be mutually compatible, all LEO RDSS systems would fail the compatibility test.

As a case in point, Loral predicts that its downlinks would cause a 3.7% increase in noise power in a victim RDSS receiver, which would be considered to be an acceptable level of interference. However, Loral's analysis is based on several dubious assumptions, including: (1) an "average" loading of only one user per Globalstar satellite antenna beam; (2) a voice activity factor of 40% applied to this one user; and (3) a Globalstar satellite EIRP of only 12 dBW per channel. Loral Application, Appendix 6, at 51. As an initial matter, it is interesting that Loral would propose to construct an expensive system consisting of 24 to 48 satellites if the average loading is only one user for each of six beams per satellite. In any case, average interference is not indicative of electromagnetic compatibility; peak interference must be evaluated assuming a fully loaded Globalstar satellite (about 466 users per beam). Voice activity factors can be applied against the power of fifty or more channels to determine the mean power, which will have a small statistical variance; however, when applied to less than twenty five channels as was done by Loral, the mean power is significantly

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be feasible in light of the needs of ISM and other radio services.

underestimated and the variance of the power is high. If interference at full loading of a Globalstar satellite were considered (466 virtual voice channels per beam), the mean number of simultaneously active downlink channels would be about 0.4 x 466 virtual channels, or 186 channels (with low variance), as opposed to the single channel assumed by Loral. Further, under ideal line-of-sight propagation conditions, the 12 dBW EIRP assumed by Loral provides Globalstar margins of only 1.0 dB with respect to an operating threshold $E_b/(N_o+I_o)$ of 3.5 dB. Loral Application, at 181-183. This margin is not sufficient to compensate for signal propagation impairments that are routinely encountered. If Loral were to use EIRP levels that generate a PFD at the current limit or at the higher PFD levels it requests in its Petition, the EIRP of a Globalstar satellite would be, respectively, 2.8 dB or up to 12.8 dB higher than the level used in its interference analysis. The net effect of making only these three adjustments to Loral's interference analysis is to yield interference that is at least 25.5 dB (22.7 dB for loading/voice activity and only 2.8 dB for EIRP) higher than the level shown by Loral. Thus, the interference from the high-power downlinks of LEO satellites would cause a 355% increase in the noise power in a victim receiver, which constitutes harmful interference. This analysis is equally applicable to all the proposed RDSS-band systems, as each will require the higher PFD that has been proposed by TRW. In other words, the downlinks from geostationary RDSS systems would be severely disrupted by the downlinks of LEO satellites that operate at elevated PFD levels in order to provide voice and data communications.

Moreover, as shown in Table 3, each of the proposed systems comply with no more than three of seven RDSS technical standards.

CRITERION/APPLICANT	CCI	ELLIPSAT	LORAL	MOTOROLA	TRW
Compliance With Downlink PFD Limit	No	No	Yes	No	No
Compliance With Uplink EIRP Limit	No	No	No for system C	No	Yes
Use of Designated RDSS Feeder Link Bands	Yes	No	No for system C	No	No
All Messaging on an Ancillary Basis	No	No	No	No	No
Use of Random Access	No	No	No	No	No
Limitation of Emission Timing in Radio Astronomy Regions	No	No	No	No	No
Use of 16.5 MHz CDMA With Orthogonal Codes	No	No	No	No	No

III. AMSC'S DOWNLINK OPERATIONS IN THE 1515-1525 MHz BAND WILL NOT INTERFERE WITH AERONAUTICAL TELEMETRY OPERATIONS

AFTRCC opposes AMSC's Petition because it believes that aeronautical flight test telemetry operations would have to be relocated from the spectrum used by MSS systems.[9/] As evidence, AFTRCC claims that AMSC's frequency sharing analysis is flawed because it (1) assumes that telemetry systems utilize separate antennas for tracking and data acquisition; (2) ignores cable loss; (3) assumes 0 dBi antenna gain for the telemetry transmitter; (4) does not account for increases in test flights and transmission data rates; and (5) assumes that telemetry usage can be easily

[9/] Opposition to Petition for Rulemaking of Aerospace & Flight Test Radio Coordinating Council ("AFTRCC"), RM-7806, (October 16, 1991), at 4-5.

coordinated.[10/] All of these criticisms are based on an incorrect interpretation of AMSC's analysis. With appropriate spectrum management, implementation of AMSC's proposed MSS downlink allocations will not require any relocation of aeronautical telemetry operations; instead, the common cause of improving spectrum utilization efficiency will be advanced.

AMSC's analysis did consider separate data acquisition (TDE) and tracking (AT) systems, even though the telemetry systems used in the 1435-1530 MHz band may integrate these functions using one antenna or may accomplish only TDE. However, this means only that AMSC performed additional analysis for two aeronautical telemetry systems whereas one analysis may have sufficed. AMSC's analyses did not ignore cable loss (typically 3 dB), because such losses were embodied in the telemetry transmitter antenna input power levels supplied by NTIA. See Analyses, at 16. The telemetry transmitter antenna was assumed to have 0 dBi gain towards the receiver because that is the "expected value" that would be exceeded for all but a small percentage of the time. The fact that there are deep notches over small portions of the transmitter antenna gain pattern with some telemetry installations means that

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[10/] AMSC previously has demonstrated that aeronautical telemetry operations would not have to be relocated from the spectrum used by the proposed MSS downlinks. See "Analyses", Further Reply of AMSC, RM-7400 (Satellite CD Radio, Inc.), October 18, 1990, at 4-21. Specifically, AMSC showed that (1) MSS downlinks could share frequencies with representative aeronautical telemetry systems by virtue of geographic separation of MSS spot beams and telemetry receivers; (2) time sharing also could be implemented if more intensive frequency sharing were desired; and (3) these sharing methods could be implemented within existing aeronautical flight test telemetry and MSS frequency management infrastructures.

the received telemetry signal will undergo brief fades that limit the availability of the telemetry link. The concomitant presence of the predicted MSS interfering signals would cause no appreciable reduction in telemetry link availability; thus, AMSC's assumption is valid. AMSC's analysis did allow for increases in test flights and telemetry transmission data rates because all test ranges were assumed to be equipped for operation at full flight testing capacity and AMSC's power density considerations make its analysis valid independent of the telemetry data rate.[11/] AMSC did not assume that telemetry usage can be easily coordinated and appreciates that there already are difficulties in coordinating flight test telemetry assignments with one another. However, the additional coordination constraints attendant to AMSC's proposed

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11/ AMSC's proposed zero-impact sharing approach involves organizing flight test telemetry frequency assignments so that compatible telemetry operations are accommodated in the shared frequencies, which by definition cannot exceed the span of the proposed MSS allocation. Conversely, incompatible telemetry operations, which are in the minority, would not be accommodated using shared frequencies unless prior arrangements were made to assure that those telemetry operations would be free of interference in accordance with a time sharing agreement. Now, considering that the U.S. has determined that WARC-92 should add MSS downlink allocations to the 1525-1530 MHz band used for aeronautical flight test telemetry, the total MSS downlink allocation at 1515-1530 MHz would overlap only 15.8% of the 1435-1530 MHz band that is used in the U.S. for aeronautical telemetry. In other words, aeronautical telemetry would have (1) exclusive, uncoordinated access to 84.2% of the 1435-1530 MHz band for accommodation of any of its operations; (2) uncoordinated access to the remaining 15.8% of the 1435-1530 MHz band for its operations that are compatible with MSS downlinks (i.e., a substantial portion of all types of telemetry operations); and (3) time-coordinated access to the latter shared spectrum for its operations that are not fully compatible with MSS downlinks. Moreover, aeronautical telemetry operations already have expanded into the 2310-2390 MHz band at many test ranges. Thus, the percentage of aeronautical telemetry spectrum that would be shared with MSS downlinks may be more accurately portrayed as being in the 8.6% range.

sharing are simple and unimposing, and could be readily observed by all managers of flight test telemetry spectrum. In sum, AMSC's conclusion remains valid, that implementation of the proposed MSS allocations at 1515-1525 MHz as well as at 1525-1530 MHz (vice WARC-92) will not require any frequency reaccommodation of existing and planned aeronautical telemetry facilities. AMSC is fully prepared to work with the AFTRCC constituents and the federal government in order to implement the proposed MSS allocations through modified spectrum management procedures designed to improve spectrum efficiency.

EXHIBIT 1

EXHIBIT 1

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

INTER-UNION COMMISSION ON FREQUENCY ALLOCATIONS FOR
RADIO ASTRONOMY AND SPACE SCIENCE
(URSI - IAU - COSPAR)

SHARING BETWEEN GLONASS AND RADIOASTRONOMY

A. For some years IUCAF has addressed the problem of harmful interference from GLONASS navigation satellites to radio astronomy observations in the bands 1610.6-1613.8 MHz. Dr. B.A. Doubinsky has had a particular charter to address this problem and communicate with the GLONASS Administration in the USSR.

B. This report records substantial progress in negotiations between the GLONASS Administration, the USSR Scientific Council for Radioastronomy and IUCAF.

C. The initial step was a letter to the GLONASS Administration from the President of the USSR Academy of Sciences. As a result, a meeting was held in Moscow on 23 October 1991 at the USSR Academy of Sciences, chaired by Academician V.A. Kotelnikov. The meeting was attended by members of the GLONASS Administration, the Soviet Defence Department, IUCAF, the USSR Scientific Council for Radioastronomy, members of INTERKOSMOS and a Russian radio astronomer (Dr. V.P. Slysh).

D. IUCAF presented a document to the meeting which set out the nature of the interference experienced by the Radio Astronomy Service (RAS), and proposed the setting up of a Working Party to examine methods of reducing the interference at 1610.6-1613.8 MHz and 1660-1670 MHz.

E. After extensive discussion the meeting agreed to a Resolution to:
- Set up a Coordinating Group comprising members of the GLONASS Administration, the USSR Scientific Council for Radioastronomy and IUCAF. This Coordinating Group will study sharing at 1610.6 to 1613.8 MHz.
- Modify future GLONASS satellites with filters to remove the interference in the band 1660-1670 MHz by the end of 1994.

F. The Coordinating Group has met twice in Moscow, on 24 and 25 October 1991. In the Minutes of the meeting of 25 October, four steps are proposed for the sharing studies:
1. IUCAF to provide GLONASS with the performance characteristics of radio astronomy stations.
2. GLONASS to analyse the potential of reducing the interference to the RAS in the band 1610.6-1613.8 MHz.
3. Joint discussions of the results of the GLONASS analysis on the potential to decrease the interference at 1610.6-1613.8 MHz.
4. Development of a joint program to observe GLONASS emission from RAS stations, with participation of representatives of the GLONASS Administration.

G. The Resolution and Minutes are available in Russian and English versions. The Resolution is signed by Akademician V.A. Kotelnikov. The Minutes are signed by V. Gorev (GLONASS), B.A. Doubinsky (Scientific Council for RA) and B.J. Robinson (for IUCAF).

H. Speed is of the essence - Step 2 in Section F is to be carried out within 3 months of receiving the information on Step 1. Step 3 is to be carried out not more than 3 months after receiving the results of the analysis in Step 2. Step 4 is to be carried out within 2 months after the meeting in Step 3. Thus IUCAF proposes to act with all speed in carrying out Step 1.

B.J. ROBINSON

DECLARATION

I, Thomas M. Sullivan, do hereby declare as follows:

1. I have a Bachelor of Science degree in Electrical Engineering and have taken numerous post-graduate courses in Physics and Electrical Engineering.

2. I am presently employed by Atlantic Research Corporation and was formerly employed by the IIT Research Institute, DoD Electromagnetic Compatibility Analysis Center.

3. I am qualified to evaluate the technical information in the Reply Comments of American Mobile Satellite Corporation. I am familiar with Part 25 and other relevant parts of the Commission's Rules and Regulations.

4. I received, in 1982, an official commendation from the Department of the Army for the establishment of international provisions for the worldwide operation of mobile earth stations.

5. I have served in the CCIR as Vice-Chairman of IWP 8/14, and chaired Working Groups in IWP 8/14 (Melbourne) and IWP 8/15 (Helsinki), that addressed detailed MSS frequency sharing matters in the CCIR preparations for WARC-92.

6. I have been involved in the preparation of and have reviewed the Reply Comments of American Mobile Satellite Corporation and the Technical Appendix thereto. The technical facts contained therein are accurate to the best of my knowledge and belief.

Under penalty of perjury, the foregoing is true and correct.

November 14, 1991
Date

Thomas M. Sullivan
Thomas M. Sullivan

CERTIFICATE OF SERVICE

I, Jacqueline L. Mateo, a secretary in the law firm of Fisher, Wayland, Cooper and Leader, do hereby certify that true copies of the foregoing "REPLY COMMENTS OF AMERICAN MOBILE SATELLITE CORPORATION" were sent this 14th day of November, 1991, by first class United States mail, postage prepaid, to the following:

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